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BULLETIN

OF THE

NEW YORK STATE MUSEUM

OF

NATURAL HISTORY.

No. 5.

November, 1888.

THE WHITE GRUB OF THE MAY BEETLE,

By J. A. LINTNER, Ph. D.,
State Entomologist.

PRINTED FOR THE MUSEUM.

ALBANY:
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The White Grub of the May Beetle,

Lachnosterna fusca.

It may safely be asserted that the last twenty-five years have been signalized by greater progress than had been made in the preceding century, in economic entomology — that science that, through the study of insect lives and insect habits, tends to promote the comfort, welfare, happiness, and prosperity of society at large. In every direction it has shown a marked advance — in a knowledge of the insects with which it has to deal, the various insecticides employed for the destruction of injurious species, the mechanical devices used in the application of insecticides, and a wide distribution of the results of the studies, in these several directions, of our ablest entomologists. So marked has been this progress, that I need not at this time dwell upon it, for it must be evident to all who have given the slightest attention to the study. Insect depredations, to an extent elsewhere unknown, imperatively demanded that means should be found for their control. In recognition of the need, and in response to the call, provision, through State aid of the means essential to the study, was made, and those were found who were ready to devote themselves enthusiastically to the work. As the result, we are able to say, that there is to-day, within the reach of our agricultural community, a literature which offers them means for protection from their insect foes, superior to that of any other country of the globe. But, while boasting of this progress, I should fail of giving honor to whom honor is due, if I neglected to recall the fact, that at the very basis of this progress lie the labors of Dr. Asa Fitch, called to his work thirty years ago by the New York State Agricultural Society, and sustained therein for nearly a score of years, by appropriations obtained from the State, through the instrumentality of the Society. True, the labors and writings of Dr. Harris, of Massachussetts, in his studies of insect habits, and of preventive and remedial measures against a few species, initiated economic investigations, and prepared the way for more extended

research; yet comparatively little could be accomplished in so vast a field, until specialists could be summoned to the work, prepared to devote to it their entire time, and their best abilities.

But the progress of which we boast is only great by comparison with the ignorance that formerly prevailed, when directions were given in our agricultural journals "how to destroy *the* cut-worm,"* and "how to prevent caterpillar attack." When measured, however, with what remains to be accomplished, the work seems but barely to have been entered upon — so immense is the number of species to be studied, so varied are their habits, and so secretly are many of their depredations conducted. While the last decade has contributed to our literature the life-history of a large number of destructive species, and has enabled us to find their most vulnerable point of attack and the most effectual means of destruction, there still remain several of our more injurious pests, which, as yet, we know not how to control, or how to prevent at times their wresting from us the products of our toil or the objects of our pride.

We need not be ashamed to make this confession. It in no degree invalidates the importance of entomological investigations. It is simply a consequence of the partial investigations thus far made — commenced only by those who have but recently passed off the stage, and continued by a paltry number of successors; for, as I have elsewhere stated, there are not within the 3,000,000 of square miles comprising these United States, more than ten persons who are permitted to devote their entire time to the furtherance of economic entomology. If, by a wise provision, this number could be quintupled, through each one of the several States contributing its quota, what rapid progress might be made through such an increased and diffused coöperation. My experience of thirty years in the study of insects enables me to make the assertion, that *there is not a single insect pest, the depredations of which we can not materially control, whenever its entire life-history becomes known to us.*

The exposed habits of the larvæ of most of our Lepidoptera (butterflies and moths), they being external feeders by day upon various plants, shrubs and trees, have made them comparatively easy subjects for study. It is different when we have to deal with

* In the genera of *Agrotis*, *Mamestra*, *Hadena*, and a few others closely allied, over four hundred United States species of moths have been described, the larvæ of most of which, if not all, may be classed as *cut-worms*.

Coleoptera (beetles), where the larval or grub stage is generally concealed. This is why the early stages of so few of our Coleoptera have as yet been discovered and described.

When, in addition to a hidden, subterranean, larval life, we have also in the life-history the perplexing element of a greatly prolonged and unknown larval stage, the problem of how best to deal with our insect foes becomes a difficult one. In the Coleoptera, among the *Elateridæ* and the *Scarabeidæ*, we have two groups which unfortunately are in this category. The life-histories of the *wire-worms* and of the *white grubs* are unknown to us, and even the duration of their larval period has not been definitely ascertained. They are among the more serious pests of the agriculturist, and we do not know how effectually to prevent their depredations. Many experiments have been tried for their control, some of which have been partially successful. Not awaiting more positive and perfectly satisfactory results, it seems proper that there should be furnished the public from time to time such an epitome of what has been ascertained as may permit of its beneficial use.

It is therefore proposed, at the present, to present a summary of our knowledge of the May beetle, *Lachnosterna fusca* (Frohl.).

The larva of this species has, by common usage, received the name of "the white grub." It is not a well-chosen name, since there are several allied forms to which it might be quite as well applied, but it serves, from its general adoption, the purpose of separating it from other insects when we would speak of it. The perfect insect has in like manner been named the May-bug or May-beetle, and the June-bug or June-beetle. As it is a frequent visitor in our houses, where it is attracted to light, nearly every person, doubtless, has made its acquaintance in childhood. It is a thick-bodied insect of an oval form, and of a dark brown color, and measures

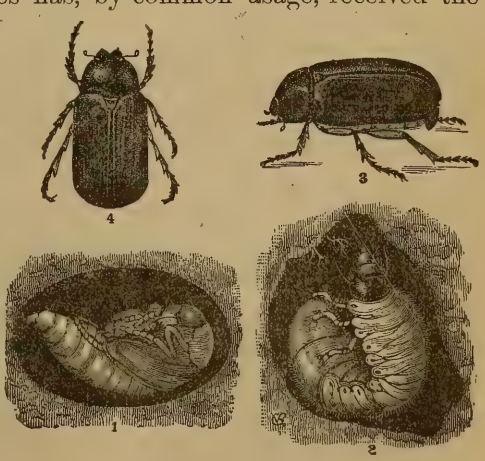

FIG. 1.—The May-bug, LACHNOSTERNA FUSCA; 1, the pupa; 2, the white grub in its ground cell; 3 and 4, the beetle.

about eight-tenths of an inch in length. Its wing-covers are shining and smooth, with the exception of two or three slightly elevated lines on each, and numerous minute impressed dots. The short antennæ terminate in three yellow leaflets or plates. The breast is covered with fine, glossy, yellowish hairs, from which it (together with the other species of the genus) owes the generic name of Lachnosterna, signifying *woolly-breasted.* The legs are tawny yellow, with black upon the joints. In the accompanying figure it is shown in a side and back view in 3 and 4.

THE WHITE GRUB.

The larva may be characterized as a large white, soft grub, with some scattered fine hairs, a flattened, brownish or light mahogany colored head, with six distinct, rather long legs on the front part of the body (the first three rings), and the hinder portion of the body considerably the thickest, as shown in the accompanying figure. When taken from the ground, it usually assumes a curved form, its head and terminal end nearly meeting. When full-grown it is almost the size of a man's little finger. In the preceding figure, at 2, it is represented as lying within a cavity made by it in the ground, while feeding upon the roots of its food-plants.

FIG. 2.—The white grub.

There are several other "white grubs," similar to this in general appearance, but as they have habits in common, to a great extent, it is not necessary, except where observations are desired for scientific uses, that they should be readily separable. From a very similar species, however, which occurs in manure, it is important that it may be distinguished, lest proper manuring should be withheld, through fear that the May-bug would be conveyed with it. The May-bug grub does not occur in manure, as its food consists of living vegetable matter.* The grub which is frequently found abundantly in dung-hills, and may be met with under the droppings of cows in fields, is exclusively a dung feeder. It is known in some localities as the "muck-worm." Its scientific designation is *Ligyrus relictus* Say. The following features, by which the two may be separated, have been pointed out by Mr. Walsh. In

* The grub appears not to be exclusively a vegetable feeder, for it has been observed feeding on the eggs of the Rocky Mountain Locust, *Caloptenus spretus* (Riley, in Rept. Commis. Agricult. for 1883, p. 174).

the latter species, there may be seen on its back through its semi-transparent skin, along the entire length of the body, a lead-colored line, denoting its intestinal canal filled with the black dung upon which it has fed. In the true white grub, the *L. fusca* larva, it is only near the terminal end of the body that it shows a lead-colored appearance, because it is only at this portion of the canal that the roots upon which it feeds have become digested and converted into a dark-colored excrement (*Practical Entomologist*, i, 1866, p. 60).

THE EGG.

"The eggs are white, translucent, spherical, with an average diameter of 0.09 inch. They are deposited between the roots of grass, and are inclosed in a ball of earth before deposition, as the cavity is sufficiently large for the egg to roll about in." (Riley, Fifth Report, 1873, p. 55.)

It would appear that the above is given from the personal observations of Prof. Riley, or upon reliable information communicated to him. If this be so, then the following statement communicated to the *Country Gentleman*, of August 27, 1874 (p. 547, c. 4), can not be accepted: "Two years ago, I repeatedly saw in a garden the female depositing her eggs while flying — just at dusk — an inch or so above the ground: These eggs were polished white, as large as pigeon-shot, and dropped singly. This is in contradiction to the 'authorities,' for it is stated that the female digs again into the ground and deposits about thirty eggs in one hole" (T. J. Burrill, Champaign, Ill., professor of botany in the Illinois Industrial University).

Beyond the above, I have no knowledge of any publication of observations upon the egg-laying of this species, the construction of the ball of earth in which the eggs are said to be first inclosed, or the manner of its burial. How the ball-making and its burial to a considerable depth, in sod, can be accomplished by the aid of feet so seemingly unfitted for such operations is incomprehensible to me.

INJURIOUS CHARACTER OF THE INSECT.

The May-beetle may with propriety be named among our most injurious pests. It has attained the unenviable notoriety of being pronounced "one of the very worst and most insidious of the farmer's foes." If a list of our insect enemies were arranged in the order of relative importance, this species would, I think, find place among the first twenty. It is a native species, and very early

notices appear of its serious injuries. It was first described nearly one hundred years ago — in 1792. Unfortunately, its depredations are evidently upon the increase, particularly within our own State, as appears from the following extract, and from the numerous inquiries received by me, of late, for approved and effectual means for the arrest of its ravages.

From Washington county, N. Y., in 1881, we have this statement: "The widespread havoc which this insect has caused this year, and the fact that its ravages are increasing with alarming rapidity, is my excuse for referring to the subject. The damages in this county amount to, probably, thousands of dollars annually, and are increasing."

The extent that these depredations have already attained is a sufficient warrant for this present notice of them. In their consideration, those committed in the early stage of the insect — that of the grub — will first be referred to.

INJURIES FROM THE GRUB.

Dr. Harris writes: "They subsist on the tender roots of various plants, committing ravages among these vegetable substances, on some occasions of the most deplorable kind, so as totally to disappoint the well-founded hopes of the husbandman."

To Grass.— Dr. Fitch thus notices it: "These grubs feed upon the roots of grass and other plants, which they cut off a short distance beneath the surface; and when they are numerous they advance under ground like an army, severing the turf as smoothly as though it were cut with a spade, so that it can be raised up in large sheets, and folded over or rolled together like a carpet. Often from a dozen to twenty grubs will be exposed in every square foot when the turf is thus raised. Large patches of this kind will occur in the middle of a meadow or pasture, every blade of the grass being brown and dead" (*3d, 4th and 5th Repts.*, 1859, p. 53).

In some pasture lands near London, Ontario, throughout entire fields "the roots of the grass had been so eaten that the turf could readily be lifted by the hand by the yard, and underneath were thousands of the grubs feeding on the remaining fragments of the roots. In one instance, a field had been so completely destroyed that the farmer had set fire to the withered grass, with the hope of scorching the enemy to death" (*Canadian Entomologist*, xiii, 1881, p. 200).

A report from North Pawlet, Vt. (*New England Homestead*, Nov. 8, 1884), states: "There is, at a low estimate, between three hundred and four hundred acres of land in this town that looks as barren as our roads, so far as anything green is visible. In our back lots a good deal of the dry turf has been turned over by skunks, coons, foxes and crows, in search of the grub."

To Corn.— The accounts given of its destructiveness to corn are numerous. Not only does it cut off the young corn when a few inches high, but it will also destroy full-grown corn over entire fields. On Prairie Ronde, in Michigan, it appeared in such numbers as nearly to destroy many fields of corn. Upon examination of a few corn stalks left standing in a field, the roots were found eaten off to within a few inches of the stalk, and often from three to five large grubs in a hill. Most of the corn was killed early in the season, and the few stalks left were dying a lingering death, without producing any grain (*Practical Entomologist*, i, p. 60).

A gentleman from Nine Mile Prairie, Missouri, writes: "They are destroying whole fields of corn. I have seen fields where they have destroyed the corn in patches for rods around, leaving the ground as bare as the traveled road. They seem to destroy the tap-root first, and afterward prey on the laterals" (*Practical Entomologist*, i, p. 61).

From Washington county, N. Y., we have this statement and estimate of injuries to corn from the grub, in the year 1881: "A large area of corn, in the aggregate, has been badly injured or entirely destroyed. On my own farm they caused the loss of one hundred bushels of corn alone; much of it would pull up by the roots when struck by the knife, frequently exposing to view from five to fifteen grubs" (*Country Gentleman for Dec.* 29, 1881, p. 851, c. 3).

Mr. Glover records their extraordinary abundance in Grayson county, Virginia, in 1874, where as many as one hundred and ten were counted in a single hill. They were also, during the same year, quite destructive to corn crops in Huntington county, Indiana, and in Montgomery county, Missouri (*Report of the Commissioner of Agriculture, for* 1874, p. 129).

To Strawberries.— It has long been known as especially addicted to feeding upon the roots of the strawberry. Prof. Forbes, in his excellent *Address on Insects Affecting the Strawberry*, read before

the Mississippi Valley Horticultural Society, at New Orleans, on February 22, 1883, represents it (page 27 of Author's edition) as "perhaps the most unsatisfactory insect with which the strawberry-grower has to deal, offering the fewest opportunities for effective attack. The roots of the plant are often destroyed by it to a degree to impair seriously the value of the plantation." Mr. B. D. Walsh has written of it that it "is particularly destructive to strawberry beds and is probably one of the chief reasons why this plant will not last more than a few years on the same spot of ground in this country" (*Pract. Ent.*, iii, p. 60). Dr. Packard records its ravages at Salem, Mass., where many plants were killed by its eating the main roots and thus passing from one plant to another (*Third Report Inj. Ins. Mass.*, 1873, p. 6).

To Potatoes.— In Washington county, N. Y., during the year 1881, the grub is charged with having devoured whole fields of potatoes.

Hundreds of bushels were reported as having been made unfit for market, in North Pawlet, Vt., in 1884, by the grubs having eaten holes into them (*New England Homestead, for Nov.* 8, 1884).

To Wheat.— Of its injuries to wheat and other grains, Professor Webster has written: "During autumn there is hardly a field of wheat here in Indiana that does not, to a greater or less extent, show the effects of their voracious appetites. Their method of work in the grain fields seems to be much more erratic than in grass lands, as the many clusters of from two to twenty, or perhaps more, dead plants that have been eaten off below the surface, illustrate. Their work in spring wheat, and oats during spring, is usually less noticeable, and we have never observed the grubs feeding on the roots of spring-sown grain later than the fifteenth of May."

To Barley.— Professor Webster also reports that the larvæ were observed in the University Experiment farm at La Fayette, Ind., cutting off the roots of the full-grown and fully-headed grain. As late as the twenty-eighth of June they were causing whole stocks of the straw to wither and die before the kernels had filled (*Ann. Rept. Comm. Agriculture, for* 1886, p. 575).

INJURIES BY THE BEETLE.

Many of our insect pests are injurious only in their larval stage, except through the evil that they originate in the deposit of their eggs. Of this class are all of the extensive order of Lepidoptera, embracing the butterflies and moths, which, in their winged stage, are unprovided with jaws for biting. Their slender and flexible tubular proboscis, fitted only for imbibing liquids, can not be used for any serious harm — in this particular, unlike the rigid, stouter proboscis of the Hemiptera or bugs, which is capable of inflicting serious and varied injuries. The powerful jaws with which many of the Coleoptera, or beetles, are armed, are often fitted for, and employed as, formidable instruments of offense. The May-beetle while, from the character of its food and a life-period of short duration, it is less injurious than its insatiate and long-lived grub, is still chargeable, as a leaf-eater, with extensive depredations at times upon many of our fruit, forest, and shade trees. Dr. Fitch has written of them as "gathering by night upon the trees and eating the leaves, sometimes in such numbers as to wholly strip the foliage from the choice varieties." Prof. Riley states: "I have known the Lombardy poplar to die, in consequence of the utter denudation they caused; while groves of both pin and post oaks [*Quercus palustris and Q. obtusiloba*] * * * were thoroughly and suddenly denuded by them" (*First Report Ins. Mo.*, p. 157).

Of the fruit trees, the cherry and plum appear to be preferred. It was thought by Mr. Walsh that their swarming upon these trees, as they occasionally do, was not usual, except in the eastern States, as he had not known it to occur in the valley of the Mississippi (*Practical Entomologist*, i, 1866, p. 62). But that they are, at times, quite as abundant in that region appears from the record, that in Cameron, Missouri, "they swarmed during the last of May, 1866, making a noise on the trees like the coming up of a storm of wind and rain" (*American Entomologist*, i, 1868, p. 37). Among other trees, the beetle is recorded as feeding upon the oak, the maple, and the beech.

Mr. W. L. Devereaux, of Wayne Co., N. Y., writing in 1886, states: "The May-beetle is very abundant in this county this year, and it has completely stripped the foliage from most of the late infoliating trees like the species of walnut, ash, and oak (*The Husbandman for June* 23).

ABUNDANCE OF THE BEETLE.

The immense numbers in which the insects sometimes congregate in seasons of their unusual abundance is so well known that two notices only will be given of such gatherings. A correspondent from Central Maryland has sent me the following paragraph:

> The land seems to be full of them. They lie quiet during the day, but in the night, in the neighborhood and around and among the branches of two weeping willow trees near my house they make a continuous humming noise with their wings, and after the sultry evenings the noise made by them is a continuous roar all through the night.

In the *Rural New Yorker*, of July 10, 1886, is the following notice of an extraordinary flight of the beetles:

> An immense swarm of June-bugs settled down on Pekin, Illinois, Monday evening. Millions of them flew against an electric light on a street corner, and were burned to death. Five wagon loads were gathered up afterwards from the ground beneath the lights, and thrown into the Illinois river.

LIFE-HISTORY.

When I say that the life-history of this insect is not known, I offer the best reason for our inability to give effectual means for preventing the heavy annual losses that it inflicts upon us. The brief outlines of a history that are to be found in our entomological reports appear to have no better foundation than a presumed agreement with that of the European cockchafer, *Melolontha vulgaris*— a very poor basis, it may be remarked, for, long as that notorious pest has been known and studied, the knowledge of its transformations is far from complete. Dr. Harris gives no details, but contents himself with the very broad statement that "the habits and transformations of the common cockchafer of Europe * * * will serve to exemplify those of the other insects of this family." Even so accurate an observer as Dr. Fitch, thoughtlessly and unwisely, we think, committed himself to the following statement: "Every thing known respecting the history of our May-beetle and its transformations concurs to show that it is exactly analogous to the cockchafer or May-bug of Europe." In truth, the European cockchafer, of whose excessive abundance and ravages at times we have had such graphic accounts, is not closely allied to our May-bug. It belongs to another genus — *Melolontha* — which is entirely unrepresented in this country.

Professor Riley presents the following history, unaccompanied with the authority or observations supporting it: "Soon after pairing, the female beetle creeps into the earth, especially wherever the soil is loose and rough, and after depositing her eggs, to the number of forty or fifty, dies. These hatch in the course of a month, and, the grubs, growing slowly, do not attain full size until the early spring of the third year, when they construct an ovoid chamber, lined with a gelatinous fluid, change into the pupæ [shown in the accompanying figure], and soon after into beetles. These last are at first white, and all the parts soft, as in the pupa, and they frequently remain in the earth for weeks at a time, until thoroughly hardened, and then, on some favorable night in May, they rise in swarms and fill the air. It is very probable that under favorable conditions some of the grubs become pupæ, and even beetles, the fall subsequent to their second spring; but growing torpid on approach of winter, remain in this state in the earth, and do not quit it any sooner than those transformed in the spring. On this hypothesis, their being occasionally turned up in the fresh beetle state at fall ploughing, becomes intelligible" (*First Report Ins. Mo.*, p. 157).

FIG. 3.—The pupa of the May-beetle.

In all thus far written of the transformations of this insect, the element of uncertainty largely prevails. It does not appear that the larval life-duration has in a single instance been ascertained, and many such determinations would be required in order to establish a rule of uniformity or the range of variation. Observations sufficiently reliable for use in building up a life-history are almost wholly wanting. The following are of some value:

In Clinton county, Missouri, the beetles swarmed late in May of 1866, from which eggs were doubtless deposited in June (the female *is said* to live for about a week). The grubs [from these eggs] were small, and not very injurious in 1867. They were "full-grown, fine, fat fellows," in the autumn of 1868 (*American Entomologist*, i, 1868, p. 37). From the above we educe: If the larvæ were then as reported, full-grown, the beetles from them would appear in May of 1869, three years from their preceding appearance. The grubs may have either transformed into pupæ in the autumn of 1868 or spring of 1869 — in the third year of their life. Their larval period would then have been either two and one-third or two and three-fourths years.

Dr. Packard records his having found the pupæ "in little rude cells or chambers, about six inches under the mould * * * in Maine, late in May" (*3d Report Ins. Mass.*, 1873, p. 7).

I will here quote, from its obscure resting place, where it seems to have been overlooked, a somewhat circumstantial history of the transformations of this insect, which from the absence of technicalities and its general character, would seem to be the personal observations of the writer, and, therefore, of considerable value. It is from the *Patent Office Report* for the year 1852, Pt. ii, *Agriculture* (p. 219), and is a portion of a report upon the crops of Ulster county, N. Y., made by David L. Bernard, of Clintondale.

Corn is extensively cultivated in this county, and is considered most remunerative at present. It seldom fails with us to produce a fair yield, except in seasons when the *larvæ* of a beetle are present with us. When these *grubs* prevail to a considerable extent, neither good husbandry nor high manuring can secure us a crop; and perhaps no other county has for the past twenty years suffered more loss from this, than Ulster. This formidable enemy to agriculture seems gradually to be leaving us, in all probability to appear in some other place, and there to renew the same destructive process practiced on us. In order to give this *beetle* a slight introduction to whom it may concern, I will give a brief description of its general appearance and habits. The bug or beetle is about three-fourths of an inch in length, of a dark brown color, and may be seen in large numbers flying through the air, in the early part of the evening, about the last of April or first of May. They deposit their eggs generally in the month of June, on grass land, on soil that is light or loamy. The larva is hatched from the egg during the month of August, and feeds upon the roots of vegetables until the ground becomes frozen; it then descends below the frost, and there remains in a state of torpidity until the following spring. As the frost leaves the ground it ascends to the surface (exhibiting no increase of growth during the winter), and again resumes its former mode of living, carefully secluded from the rays of the sun; feeding on the roots of almost all kinds of grasses and vegetables. Its movements are slow and sluggish; its color nearly white, with the exception of the head, which is red; it has six legs, three on each side; it is at this age about one inch in length. It continues its destruction of all green vegetable matter with which it may come in contact, until the ground becomes frozen again. This is its most destructive season through its progress of change. As the ground becomes frozen, it again descends below the frost (in some instances six feet below the surface), as before remains torpid until the next spring, when it again appears at the surface, being now about one and one-quarter inch in length. It continues to feed as usual upon vegetable substances

until about the middle of June, when it ceases to feed, descends deeper into the earth, and becomes torpid until about the middle of August, when a complete change occurs. It opens lengthwise from the head, back near one-half its length, and forthwith appears in the chrysalis state, in which it remains nearly inactive until about the last of September, when it changes into a perfect state or beetle, and still remains in a nearly torpid state until the following spring, when, about the last of April, it ascends to the surface and immediately commences to reproduce its species.

It has thus far baffled the ingenuity of man to prevent its ravages, while fields of timothy have, within a few weeks, been entirely destroyed by this grub, and thousands of acres of corn have been totally lost in this county by its ravages.

According to the above statement, the larval stage proper would be of the duration of *two years*.

DISTRIBUTION.

This insect is one of very extensive distribution, being found in all parts of the United States, and extending northward into British America, where it occurred in Kirby's collections in north latitude 54° — the latitude of Labrador and Hudson's bay.

ITS ENEMIES.

An excellent reason for the amount of injury which this insect imposes upon us is found in the few insect or other enemies that prey upon it, protected as it is by its subterranean life in its first three stages, and its unusually brief final stage. Only one insect parasite is known to attack it. It has, however, several vertebrate enemies which render good service in restraining its unlimited increase; these will first be noticed:

The Skunk.— There is abundant testimony of the service rendered by skunks in the destruction of the grubs, and to the expertness which they manifest in the discovery of their presence, and in making them their prey. It has been thought that one reason among others for the multiplication of the grub in localities in the Western States and elsewhere is to be found in the wholesale slaughter of the skunk since their skins have obtained commercial value as a fur. In the *Country Gentleman* of December 1, 1881 (p. 778, col. 2), we have the following observations: "A few years ago, before skunk skins became so valuable as furs, I had a pair of half-tamed skunks which I used to let out every evening to dig for grubs, and it was wonderfully interesting to see their infallible

scent or instinct in discovering the location, and then their astonishing celerity in digging out and gobbling the grubs. But most astonishing of all was the quantity of grubs those two little beasts would devour every evening. I have often watched them, and, incredible as it may seem, I could not say that they ate less than half a bushel daily!" To the above statement, the suggestion is added, that a very valuable ally might be obtained in our war against the white grub by removing the odoriferous glands from the skunk, and domesticating him for employment as a grub killer.

Mr. Hoard, of Wisconsin, has made the following statement: I once had eight acres of hops, in which the white grub was very destructive. I went through the hops one morning, when there had been a couple of skunks in the hops in the night, and I found by actual count that they had investigated 400 hop hills, and I thenceforth became a very firm friend of the skunk (*Trans. Wisc. St. Agricul. Soc.*, xix, 1881, p. 298).

A correspondent of the *Practical Farmer* had watched the habits of skunks for twenty years, and found their natural food to be insects. He had a field of corn attacked by the white grub, in which he afterwards observed numerous small, round holes where these insects had been taken out by the skunks and devoured. He believed that the skunk should stand first in the list of insect destroyers, as it fed upon other noxious insects in addition to the white grub (*Country Gentleman for Jan.* 25, 1877, p. 527).

A correspondent from Washington county, N. Y., gives this testimony: "Before skunks began to be hunted, we had no trouble with the white grub, and I think they kept them down. I often found my corn-hills rooted into, evidently by skunks in search of grubs. Those dug into early in the season made a fair crop, while those untouched until later were destroyed. I have also seen the same signs in meadows and pastures" (*Country Gentleman*, Dec. 29, 1881, p. 851).

Not only are the grubs so eagerly sought for and devoured by this animal, but it is also, according to Dr. Fitch, a natural destroyer of the beetle, its food consisting almost entirely of this insect during the short period of its existence (*Third Fitch Rept. Ins. N. Y.*, p. 55). This is in accordance with the statement of Dr. Harris, to the effect that the beetles are devoured by the skunk, whose beneficial foraging is detected in our gardens by its abundant excrement filled with the wing-cases of these insects.

The Raccoon.— Dr. Thomas (*Sixth Rept. Ins. Ill.*, p. 98) names the raccoon as one of the carnivorous animals that prey upon this insect, but does not state to what extent it destroys it.

In the report from North Pawlet, Vt., page 9, it is mentioned as one of the animals that had been digging in the dry turf for the grubs that had caused the death of the grass.

The Fox.— In the same report, this animal is also included among those which had been rendering good service to the farmer, and the following suggestion is added: "There is now a bill before the Legislature authorizing the State to pay one dollar a head for all foxes killed in the State. Now, if these grubs continue with their sad havoc from year to year, I should think it a wise legislative act to pass a law prohibiting the killing of all wild beasts and birds which subsist in part on these grubs."

The Mole.— Professor Claypole, a careful observer of the habits of insects and other animals, permits us to claim the mole as an auxiliary in our warfare against the white grub. The following is what he saw, writing from Yellow Springs, Ohio: "In digging potatoes this year, I observed the runs of a mole in all directions through the ground. It was a piece of old sod, and very much infested with white worms, the larva of the cockchafer, *Lachnosterna fusca.* Many of the potatoes had been partly eaten by these worms, but I observed that wherever a mole-run traversed a hill of potatoes no white worm could be found, even though the half-eaten potatoes were proof of his former presence. The inference is fair that the mole had found him first and eaten him, and very likely the mole's object in so thickly tunneling this piece of ground was to find these grubs" (*Canadian Entomologist*, xiv, p. 17).

A writer in the *Indiana Farmer* says: "Last year I put twelve moles in my strawberry patch of five acres to catch the grubs, and they did the work. I never had a dozen plants injured during the summer, either by the grubs or moles. I know some people do not care for moles on their farms, but I want them in my strawberry patch."

The Gopher.— In Michigan, upon some new land badly infested with white grubs, and where the gopher was also abundant, the attempt was made to exterminate these animals, until they were observed, in the autumn, busily engaged in digging up and eating the grubs.

The Frog.—This animal undoubtedly destroys large numbers of the beetle, at the time when their destruction would be of the greatest benefit, during the night of their emerging from the ground and before they have deposited their eggs. Dr. Hoy, of Racine, Wis., relates that on the twelfth of June, having occasion to go across a little piece of prairie, he saw a large spotted frog, *Rana* ——, very large and hardly able to jump. He captured and opened him, and to his surprise found within him eight May-beetles. Others were caught and examined, and each was found to contain from one to four of the beetles (*Trans. Wisc. St. Agricul. Soc.*, xix, 1881, p. 297).

Other Mammals.—Among the mammals appointed to check the ravages of the cockchafer and allied leaf-beetles in Europe, according to Latreille, are the badger, weasel, marten, bats, and rats. The same animals, no doubt, render more or less service in restricting the increase of the May-bug in this country.

Domestic Fowls.—If these be watched as they follow the plow in our gardens and fields in search of such insects as may be brought to the surface, it will be seen that they show a special fondness for the white grub. Their presence during the operation of plowing should, therefore, always be encouraged.

The Crow.—The common crow feeds upon both the beetle and the grub. It is believed by many that its frequent occurrence in corn-fields is the result of its fondness for the grub, which is preying upon the young corn, rather than for the corn itself. The studies that have been so ably conducted during the last few years upon the food of birds should have settled ere this the question beyond all doubt, whether the crow is to be driven from, or invited to, our corn-fields.

Mr. Glover states that this bird has been observed to return on the appearance of the dor bug or May-beetle, and to feed greedily upon it both in its winged and larval stages.

Other Birds.—The beetles have been found in the stomach of the king-bird, *Tyrannus Carolinensis*, shot in the month of May. The robin, black-birds and jays are also said to feed upon them.

The grub has been taken from the stomach of the sparrow-hawk, *Falco sparverius*.

Insects.—The grub has also enemies among its own class, which prey upon it. Several of the predaceous beetles are said to

devour it — species of the rapacious *Carabidæ*, probably *Calosoma calidum* and others, but their names have not been recorded.

A Parasite.— While many insect attacks are restrained through the beneficent aid of other insects, which, in our gratitude, we are apt to regard as specially commissioned to perform this duty for our protection, thus far we know of but a single parasite which is waging warfare upon the white grub. This insect was described and figured by Professor Riley, in his *Sixth Report on the Insects of Missouri* (1874, pp. 123, 124), as the white grub parasite — *Tiphia inornata.* It is shown at *a* in the accompanying figure. It is one of the digger-wasps, and the ease with which these creatures are able to burrow in the ground enables this one to discover the grub in its concealed retreats, and by depositing an egg upon the body, to provide for its progeny its needed food, and to insure the death of the attacked grub. The parasitic larva, shown at *c*, having matured, it incloses itself for its changes in "an egg-shaped cocoon of a pale golden-brown or buff color, and with a soft exterior surface, in touch as well as color. * * * Upon cutting this cocoon open, it will be found to consist of about a dozen delicate layers, the outer ones soft and loosely spun, the inner ones more and more compact and paler in color." The cocoon is shown at *d* in the figure. Their presence in the ground (from the above description and figure they may be easily recognized) serve to show the parasitic attack. They have in some instances been met with in such numbers, in association with a formidable grub attack, as to arrest attention and to induce inquiry into their character.

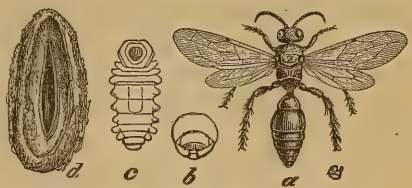

FIG. 4.—The white grub parasite, TIPHIA INORNATA.

For an interesting mention of a secondary parasitic attack — the larva of the *Tiphia*, in its turn and while within its cocoon, is destroyed by a beetle known as *Rhipiphorus (Emmenadia) pectinatus* Fabr., var. *ventralis* — see Riley, *loc. cit.*, p. 125.

From a paper recently read by Mr. Otto Lugger, before the Baltimore Naturalists' Field Club, it appears that the Rhiphophora parasite above mentioned, which destroys the Tiphia parasite, has a parasite which also destroys it. Mr. Lugger had found within the Tiphia cocoons small hymenopterous parasites — the species

not stated—showing this interesting order of events: The larva of a large Coleopterous insect (*Lachnosterna fusca*) is destroyed by a hymenopterous larva (*Tiphia inornata*); this in turn by a Coleopterous larva (*Rhipiphorus pectinatus*); and this again by a Hymenopterous larva (——— ———).

FIG. 5.—The white grub attacked by a fungus.

In connection with the parasitic attack on the white grub, it is of interest to note that Dr. F. Brauer has lately discovered a very interesting parasite upon *Rhizotregus*, an European genus belonging to the same group with *Lachnosterna*. Within its nearly formed pupa, he has found the second larval stage of a dipterous insect, *Hirmoneura obscura*—one of the bee-flies, the genus of which is represented in the United States. It is still not known when and in what manner the parasite enters the Rhizotrogus grub, but it was thought to be while the latter is in the larval state (*Science*, iii, April 18, 1884, p. 488).

The White Grub Fungus.—For another destroyer of the white grub, and the most interesting of all that we have referred to, we have to turn to the vegetable kingdom—to that low class of plants known as *fungi*. From its being so often found upon this species, it has been popularly named *the white grub fungus*. Scientifically, it is known as *Cordyceps Ravenelii* Berkeley.* It was described in 1857, but its economic importance in its association with the white grub was not known until brought to notice by Walsh in 1867 (*Practical Entomologist*, ii, 1867, p. 116) upon the reception of specimens from a large number of the grub killed by this growth, which had been plowed up in a field in Iowa. Its character was not understood at the time, Mr. Walsh suggesting that, but for the numbers found, the grub might have swallowed a seed which subsequently sprouted and grew. Later, its fungoid character was disclosed. Its general appearance is that of a pair of elongated horns, green at first, but subsequently changing to brown, issuing from

* Originally described as a *Cordyceps*, and subsequently referred to other genera, it has recently been restored to the *Cordyceps* of Fries, in *Sylloge Fungorum* of P. A. Saccardo (vol. ii, 1883, p. 573).

the lower side of the larva, between the head and the first joint. In length they vary from less than that of the larva, to three or four times as long. Its appearance, when it has attained the latter length, is shown in Figure 5.

This interesting parasite occurs at times, in considerable abundance, more particularly in the West, and South.* It has been met with occasionally in New York, specimens having been received by me from ex-Governor Seymour, occurring upon his farm near Utica, and from others.

It has been suggested that this fungus attack might be extended, through propagation and distribution of the spores of the fungus, but I am not aware that the experiment has ever been made.

PREVENTIVES AND REMEDIES.

Passing now to the more practical portion of this paper, we will consider what may be done to control the ravages of the insect of which we have been speaking, and first, the preventive means that promise protection.

Ashes.—It is stated that for strawberries, which are very liable to attack, an efficient protection is found in placing a quantity of ashes, either leached or unleached, upon the ground, before setting the plants. This is upon the authority of Dr. Barnes, of Owasso, Mich.

Tobacco.—A gentleman from Westwood, N. J., states that by digging [burying] tobacco stems into strawberry beds, the injury of the grub may be prevented (*Country Gentleman*, Oct 21, 1875, p. 669).

Rolling, etc.—Compacting the surface of the ground by treading it with sheep or cattle, or by the use of heavy rollers, might give protection from the deposit of eggs, by the inability of the beetle (if this be its habit) of excavating the earth for the purpose, and might also serve to prevent the easy passage of the grubs, if in the soil, from one root to another. But this method, which has been urged for use against many insects by English writers, seems so opposed to the condition of looseness and pulverization of the soil which is well known to stimulate vegetable growth, that we incline to the belief that whatever protection it might yield from insect injury would be counterbalanced by a stinted crop.

* Mr. Wm. Trelease has found it proving very destructive to white grubs in the neighborhood of Madison, Wis. (*Psyche*, iii, 1881, p. 279).

Gas-lime.— Although not tested by experiment, I have great faith in the efficacy of gas-lime, as a protection from the deposit of the eggs of the beetle, or, if the protection be but partial, then, for the destruction of such eggs as may have been deposited. Upon ground to be seeded or planted, the lime, fresh from the works, might be distributed and worked into the soil, but where the crop to be protected is already upon the ground, the lime should first undergo such atmospheric exposure as would permit of its use as a top-dressing without harm to the vegetation. It should be applied during the month of May or June, or as soon as the beetles are seen upon the wing. For different methods of its application I would refer to my First Annual Report, where I have treated at some length of gas-lime as an insecticide.

In referring to this preventive, Miss Ormerod has written: "Gas-lime has been tried, sprinkled broadcast, without keeping off the chafers, but if it was shoveled on in a thin layer, so that the chafers could have no cognizance by any natural instinct of what was beneath, and also could not penetrate into the soil without first fairly scuffling their way through the gas-lime, one might hope for good results. It would be well worth while to try whether shoveling ashes or dry earth, well sprinkled with spirits of tar, or with phenol, might not be of great service; or again, mulching over the roots with any suitable material that could be moistened from time to time with soft (or whale oil) soap (*Agricultural Students' Gazette* [Cirencester, England], April, 1883, i, p. 73).

Air-slacked Lime.— There is good reason to believe, from the many statements that have been made, that the foliage of trees threatened by destruction from the beetle, may be saved by a thorough dusting of air-slacked lime above and below, as far as possible, while damp with the dew — better if done in the morning. The pests dislike gritty food, which is apparently repulsive to them, and while the greater part of the caustic quality of the lime thus slacked is gone through the slacking, yet doubtless there is enough remaining to make the taste of it obnoxious.

According to the *Livermore* (Cal.) *Herald*, Mr. Julius Schrader, who owns a fine vineyard and orchard west of that town, saved his crop of apricots from the attack of June bugs by the use of air-slacked lime. His trees were swarming with the insects, which had begun to destroy the fruit as fast as it ripened. He applied the lime by dusting it through the trees, with the result of driving

away every insect, and saving the remainder of the crop uninjured. (D. W. Coquillet, in the *Pacific Fruit Grower*, i, September, 1887, p. 132).

Infusion of Burdock Leaves.— A correspondent of the *New England Homestead* gave the following as an effectual remedy for an attack of the onion maggot:

Take green burdock leaves and stalks, run them through a hay-cutter, put them in a large kettle or tub, and mash them with an old axe or mall, adding water, and pounding them to a pulp. Let it stand over night, have the decoction strong, and when you see the first sign of the maggot, use this, and it will be found a dead shot for the worm. Put it on all of the onions as a preventive. I have used it for forty years on onions. I use a sprinkler, taking off the nozzle, and pouring the solution along the rows. I seldom have to apply it the second time.

If the above was what it claimed to be — an effectual preventive of the attack of the persistent onion maggot, which no application hitherto had served to repel — it seemed that it should be equally efficient if used to prevent attack of the white grub. A test of its efficacy was, therefore, suggested to Professor C. H. Peck, who had applied to me for aid against the ravages of the white grubs in his garden. The results of its use by him were so entirely satisfactory, that a communication, in which they are detailed, made to the *Country Gentleman* of November 25, 1886, p. 893, c. 4, is herewith given:

Editors Country Gentleman.— In April last the writer moved into the country, and started a garden. In one part of it, 300 strawberry plants were set. The ground had previously been in grass, and was well stocked with the white grub — the larva of the troublesome May-beetle, *Lachnosterna fusca*. Any experienced strawberry-grower would probably say that it was a foolish operation to set strawberry plants in such land, but as no other was available, the risk was taken, and the difficulties encountered. No sooner had the plants fairly commenced growing than they began to die, one after another. The withered and drying plants were found to be nearly rootless, and, in most instances, the white grub that had eaten the roots was found in the ground under the plants.

As a first attempt to stop the destruction, the earth between the rows of plants was dug over, and the grubs thus found (about forty) were killed. But all were not found. The destruction still went on, though perhaps less rapidly than before. Wetting the ground about some of the plants with chamber slops was tried, but proved ineffectual. At the suggestion of the State Entomologist, Prof. J. A. Lintner, the burdock remedy, which has been

reported as effectual against the root maggots of the onion and cabbage, was tried. A bundle of burdock plants was gathered, cut and pounded according to directions, and soaked in water over night. With this infusion a dozen or more of the strawberry plants in different parts of the patch were watered. Under two of them, as special-test plants, living grubs were placed, that they might be in a convenient position to eat the burdock-watered roots, if they were so disposed. But they did not eat them, nor to this day have any of the plants thus treated at that time been attacked. After the lapse of about two weeks, wishing to see if the remedy was still effectual, another live grub was placed in the soil, at the roots of one of the special-test plants; but he, like his predecessors, declined the proffered roots. In the meantime, the untreated plants were dying, one after another, from the loss of their roots, till now nearly half the number have been destroyed.

But the experiment already tried had given me such confidence in the burdock remedy that the vacant places in the patch were filled with new plants, and these, together with the untreated older ones, were given a dose of burdock water. This put an end to the attacks of the white grub for at least six weeks. Then two of the late-set plants suddenly wilted, and were found to have their roots partly eaten. With this exception, no treated plants have been lost to this day. I am unable to explain the failure in the case of these two plants. Possibly they may not have received so thorough a wetting as the other plants. Notwithstanding their loss, my confidence in the ability of the burdock remedy to protect the strawberry plant against the white grub is unshaken. It may possibly be necessary to apply it twice in a season, but with the exception of these two plants, one application has been sufficient in this case. It does not appear to be at all detrimental to the growth or vigor of the plant.

We may pass now to remedial measures, and first those referring to the destruction of the beetle.

Tree-shaking.— The May-beetle has a habit in common with many other species of becoming gregarious, in times of its great abundance, when it assembles in multitudes for the night upon fruit trees. This habit permits of its destruction in large numbers, and the reduction of the following brood to the extent that its eggs have not at this time been deposited, by shaking them from the trees upon sheets spread underneath. Dr. Harris records, that in this way two pailfuls of beetles were collected on the first evening of the experiment — the number decreasing upon following evenings until the fifth, when only two beetles were to be found. He adds: "The best time, however, for shaking the trees * * * is in the morning, when the insects do

not attempt to fly. They are most easily collected in a cloth spread under the trees to receive them when they fall, after which they should be thrown into boiling water to kill them, and may then be given as food to swine" (*Treat. Ins. Inj. Veg.*, 1862, p. 31).

Dr. Fitch, in referring to this remedy, gives the time in which the trees may be shaken with the best results, as between midnight and daylight, as would appear from the observations of Mr. Milo Ingalsbe, of South Hartford, Washington county, N. Y. "He had seventy plum trees and a number of cherry trees of the choicest varieties, which never gave fairer promise of an abundant yield than at that time. But a swarm of these May-beetles suddenly gathered upon the trees, many of them being then splendidly in bloom, and in two nights, the fifteenth and sixteenth of May, wholly stripped them of their foliage, so that many of them were as naked as in winter. With their humming notes, these beetles were flying about the trees every evening until about 10 o'clock, when they would settle in clusters of eight, ten, twenty or more, and would thus remain until daylight, when they would tumble down from the trees, flying but little, however, and hiding themselves wherever convenient to stay through the day (*Third Fitch Rept. Ins. N. Y.*, 1859, p. 54).

Attracting to Light.—The beetles, in their evening flights, are readily attracted to light, as is shown in the frequency with which they fly in at the open windows of our dwellings, public halls, churches, etc., in warm evenings, and the numbers that may be seen circling about the electric lights of our streets, or lying upon the pavements beneath, to which they have fallen. This well-known propensity of the beetle may be utilized to lure them to their destruction. If a lantern be placed above a vessel of water upon which two or three tablespoonfuls of kerosene has been poured, many of the beetles drawn to the light and striking against it will be thrown into the water and killed. Many other noxious insects may at the same time be killed by this method.

In our efforts to destroy the *larva*, we are met with several difficulties, of which these may be given:

1. Applications to the ground of sufficient strength to invariably kill the grub, of which several might be mentioned, would also be destructive to a growing crop.

2. The strongest applications that may with safety be applied, would be so impaired in strength in entering and penetrating the ground as to become inefficient at a moderate depth.*

3. The grub has the ability of withdrawing itself from the obnoxious application by burying itself deeper in the ground.

In consideration of the above and like difficulties, effort should be directed toward the discovery of some substance which will act upon the grub through other means than its exceeding strength. Should it be of such a character as simply to be repulsive to its taste, there is reason to believe that, rather than to feed upon roots that are saturated with it, it would die of starvation. In this manner, perhaps, may be found the reputed efficacy of the burdock infusion and of the application next to be noticed. Experiments in this direction are very desirable.

Salt.— The application of salt has been pronounced an effectual remedy, while it has also been said to be of no avail whatever. The remedy would be so simple, and withal so inexpensive, that the claim made for it should be tested by careful experiments. It is possible that the reputed success may have resulted from its employment in the year of the greatest ravages — that preceding the transformation to the beetle, for during this latter year (next after the application), the newly-hatched grub will have made so little progress in its growth that there would necessarily be a comparative immunity from its injury. On the other hand, the ascribed failure may have followed a too economical use of the cheap material — perhaps through fear of injury to the crop. A gentleman who strongly recommends this remedy, presumably from having thoroughly tested its value, deems it essential that the salt should be used in large quantity. He writes: "The great error with those who have used it with unsatisfactory results has been its scanty application. I can assure the reader that grass or potatoes will grow luxuriantly under an application of *one ton and a half per acre*, which quantity would be sure to result in the complete extermination, not only of the grub, but every other kind of worm, and prevent the scab and other excres-

* Some of the Lachnosterna grubs ordinarily feed at a considerable depth. Thus the larvæ of *Polyphylla decemlineata* Say, has been found by Mr. Rivers at a depth of from one foot to two feet among the root-fibers of a coarse grass and roots of a Californian laurel, *Umbellularia Californica* (*Bull. Cala. Acad. Sci.*, 1886, ii, p. 69).

cences which sometimes appear on potatoes, as well as preventing rot. A less quantity, say half [three-fourths of a ton], or even two or three barrels to the acre, though of course not as effectual, will accomplish much" (*Country Gentleman, for Aug.* 3, 1882, p. 601, c. 2).

If the above testimony to the value of salt as a grub-killer shall be sustained by further experiment, I would strongly urge, in view of the periodic character of these attacks in localities, that the salt be applied *in the year of the abundant appearance* of the beetle, and preferably during the month of August or September, although no injury from the grub may be apparent. At this time the young grubs which are produced from the eggs deposited in June are within reach of the application, and may be killed far more readily than when they have attained additional powers of resistance in another year's growth.

Caustic Lime wash.— Mr. Daniel Batchelor, of Utica, N. Y., in a paper on "Lawns and Lawn Grasses," read before the Western New York Horticultural Society, at its annual meeting in January, 1885, in referring to the destructiveness of the white grub to the roots of grasses, states:

Its presence is made known by the appearance, in patches, of dead and bleaching grasses, and then is the time to attack the depredator. My method has been to pierce the sod with a steel bar to the depth of about six inches, and to make the perforations the same distance apart. Into these holes I pour caustic lime wash from the spout of a watering pot, and the pulpy fellow is done for. After the lapse of a few days the denuded surface is thoroughly raked, and some lawn seed sown.

Rooting out by Swine.— The value of swine in freeing infested grass lands from the grub has often been urged, and we think is not overestimated. I believe that this remedy will prove successful, if good rooters be employed, when other methods fail. Dr. Fitch has written of it:

"I would recommend the placing of a temporary fence around that portion of the meadow or pasture which is so thronged with these grubs, thus for a while converting the patch into a hog pasture. The propensity of these animals for rooting and tearing up the turf, we are all aware, is for the very purpose of coming at and feeding upon the grubs and worms that are lurking therein; and who knows but that this rooting propensity, which has all along been complained of as being the most vicious and troublesome habit

which belongs to swine, may after all turn out to be the most valuable and necessary to us of any of the habits with which they are endowed. I can not but think that these animals, confined upon a spot so overstocked with grubs, would in a short time ferret out and devour every one of them, leaving the soil cleansed, mellowed, manured and well prepared for being immediately laid down to grass again, or for receiving any other rotation of crops for which the proprietor may deem the spot best adapted."

Mr. Walsh, formerly State Entomologist of Illinois, had equally strong faith in the value of this method of overcoming the white-grub attack. After discoursing upon the great increase in the insect as observed in a few preceding years, its growing injury to young nurseries, and its violent irruption upon corn, which had formerly been exempt from it, he adds: "I suspect that the above phenomena are to be wholly or partially attributed to the introduction of improved breeds of hogs in the place of the old, slab-sided, long-nosed prairie-rooters, and to the passage of laws compelling people to keep their hogs under fence, instead of allowing them to run at large. * * * Within the last few years such laws have been very generally passed in the Western States. * * * Hence, I am inclined to infer that the presence of the white grub is often to be attributed to the absence of the hog."

Digging out.—When a valuable crop has been found, too late for other remedies, to be suffering from a severe attack of the grub, threatening its entire destruction, it has been saved by digging out the grubs by hand—popularly known as grubbing. In a pamphlet recently published by Mr. R. C. Haldane, upon the "Coffee Grub in Ceylon," the writer, in the discussion of several methods, states:

"When coffee is thoroughly attacked, I know of but one cure—*dig out the grub.* It is slow, weary work, but it pays. I gave my men small dagger-shaped wooden pegs, and a cocoanut shell. Another man brought a bucket round into which he emptied the shells, and then took the collected grubs and put them in a five-gallon drum of boiling water." By the above method from 100 to 150 grubs could be collected at each bush, and in one season (1882) twelve tons of coffee grubs were picked from a field, in Lindula, of eighty acres."

Without occupying more space in a review and discussion of various other methods that have been proposed for destroying the

grub, I will refer to but one other, which I regard as an effectual one, wherever it may be resorted to:

Starvation.— As soon as the attack is discovered, upon the removal of the crop, collect and burn, as far as practicable, all the vegetable material upon which the larvæ could feed. If the ground has been cultivated for vegetables, gather all the stalks, stems, vines, etc., together with the roots, in piles, and burn them. If the land be in grass, after feeding as closely as possible, plow thoroughly, and follow during the autumn with such additional plowings and harrowings as shall best tend to destroy all vegetable life. At this time, gas-lime, if procurable, should be applied. Repeat these operations in the following spring, and allow the land to lie fallow for the year. Compliance with these directions would not only starve out the white grub, but also whatever wire-worms, cut-worms, and other underground larvæ there might be present.

The fallowing of the land for an entire year may be found to be unnecessary. It is not improbable that it might be preferable that the thorough breaking up of the ground in the autumn and spring be followed with a crop of buckwheat. Wonderful efficacy has been claimed for this plant, in freeing the ground from wire-worms — the larvæ of other beetles, and we know not why it may not be equally efficient when employed against the white grub. By all means, let thorough tests of its value be made, since the trial is so simple. Hon. A. B. Dickinson, after experimenting with salt and lime for destroying wire-worms, has stated: "I have only proved one remedy for the rascals, and that is, to break the sod and sow it to buckwheat; plow late and as often as possible in the fall, and then sow it to peas in the spring; with the like plowing next fall, they will not disturb any crop the next season."

In England, a crop of mustard is regarded as an antidote against the wire-worm. In an address before an agricultural society there, the speaker, after detailing some successful experiments upon a small scale with mustard, stated as follows: "Thus encouraged by these results, I sowed the next year a whole field of forty-two acres, which had never repaid me for nineteen years, in consequence of nearly every crop being destroyed by the wire-worm; and I am warranted in stating that *not a single wire-worm could be found the following year*, and the crop of wheat throughout was superior to any that I had grown for twenty-one years." Certainly

this very successful experiment, confirmed as it is by many others that I find recorded, deserves to be faithfully tested with the white grub.

STUDY OF THE INSECT DESIRED.

I have now given the characters by which the notorious white grub may be recognized; have narrated so much of its life-history as is known to us; have told of its ravages and of the enemies that prey upon it; and, so far as I am able, have pointed out the principal means for the prevention of its depredations, indicating those which are deemed the best.

To me, and perhaps to many others, it is not the satisfactory exhibit of knowledge of the species that is desirable. As before stated, there are several points in its history upon which information is still needed. May I ask, and in return be favored with the aid of the farmers of our State toward supplying what is lacking? They have the opportunities for making valuable contributions with but little effort, and of a kind that may not be obtained from other sources. I would, therefore, beg of them, and of all others who are interested in the eminently practical work in which we are engaged, to make observation and to send me the results from time to time of some of the following points. Even in a communication of two or three lines, quite important information may be contained:

1. The earliest and the latest appearance of the May-beetle in any year.

2. The comparative abundance of the beetle in different years, particularly noting such years of unusual abundance, as may appear to indicate a periodicity of three years.

3. The presence or absence of eggs in the female beetle, to be ascertained by cutting open the abdomen and examining the contents. The female may be told by the three-leaved (when spread apart) terminal club of the antennæ being but about one-half the length of that of the male. My observations tend to the probability that the eggs are deposited before the beetle comes abroad for flight and food. It is important that this point should be determined.

4. The reëntering the ground (if so) by the female for depositing her eggs; the character of the soil entered as to its degree of compactness; and the crop cultivated thereon.

5. The manner of oviposition, if in a mass within a ball of earth as stated, or singly — the number of eggs, and depth at which placed.

It is thought that this can be ascertained the most easily by taking a few examples of each sex when freshly turned out from the ground while yet in their pale color, and confining them in a box of sod-covered earth, and, after their death, carefully examining the soil for the eggs that may have been deposited. Or the beetles uncovered by the plow in the early spring might be sent to the State Entomologist for his observation.

6. The effects of gas-tar water, ammoniacal liquid when it can be obtained, guano, phosphates and superphosphates, hog manure, kainit, sludge acid, alkali waste, bisulphide of carbon, etc., employed either as preventive of egg-deposit or for killing the larvæ. Even negative results from the use of any of the above applications should be recorded.

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